Journal of Archaeological Science 40 (2013) 3031–3045

Contents lists available at SciVerse ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

Feeding behaviour and taphonomic characterization of non-ingested rabbit remains produced by the Iberian lynx (*Lynx pardinus*)

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ARTICLE INFO

Article history:
Received 17 January 2013
Received in revised form
4 March 2013
Accepted 6 March 2013

Keywords:
Iberian lynx
Taphonomy
Actualism
Leporidae
Non-ingested remains

ABSTRACT

The rabbit (*Oryctolagus cuniculus*) is usually the most abundant taxon found in the Palaeolithic and Epipalaeolithic archaeological sites of southern Europe and the Mediterranean Basin. These accumulations may be the result of different abiotic factors, biotic agents and/or the interaction of both. For these reasons, over the last decades actualistic research has been conducted on different predators of rabbits. Among them, the Iberian lynx (*Lynx pardinus*) is an excellent candidate for study because: 1) its diet is based almost exclusively on this leporids and 2) its historical distribution overlaps with one of the most interesting areas for small game research, the Iberian Peninsula and southern France. Here we present the taphonomical analysis of non-ingested rabbit remains collected from two Iberian lynx captive breeding centers located in southern Spain. Our results show: i) predominance of the distal segment of the appendicular skeleton; ii) variable breakage patterns, with a high proportion of whole bones of the autopodium and heavy breakage of the zeugopodium and stylopodium; iii) rare bone surface modifications. Comparison of these results with those obtained for other terrestrial carnivores, such as the fox, reveals great similarities, the only difference being the more abundant tooth marks present on fox non-ingested rabbit assemblages.

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1. Introduction

The Iberian lynx, *Lynx pardinus* (Temminck, 1827) is a medium-sized feline endemic to the Iberian Peninsula. On average, the males of the species reach a weight of 13 kg while the females are somewhat smaller (Rodríguez and Delibes, 1990, 2002; Beltrán and Delibes, 1993; Blanco, 1998). The Iberian lynx has been present on the Iberian Peninsula (through the *Lynx pardinus spelaeus* (Boule, 1910) subspecies), since at least OIS 7 (García et al., 1997) and it is considered to be common throughout the late Pleistocene (Yravedra, 2005) and Holocene (Cabrera, 1914; Rodríguez and Delibes, 1990). At times, the range of the Iberian lynx extended to central and southern France from the Late Glacial to the Iron Age (Guilaine et al., 1986; Kurtén and Granqvist, 1987; Vigne, 1996; Vigne and Pascal, 2003). Currently, it is restricted to two isolated breeding populations in the southern Iberian Peninsula, comprising fewer than 200 individuals (IUCN, 2011) (Fig. 1A and B).

The habitat of the Iberian lynx is the Mediterranean forest, with preference for a mosaic environment of patches of scrub, scattered trees, herbaceous grasses and rocky areas. The Iberian lynx is a specialist predator of the European rabbit (*Oryctolagus cuniculus*), a species from which it receives between 85 and 100% of its diet, regardless of season or geographic area (Delibes, 1980). The Iberian lynx generally preys on adult rabbits, although young specimens are also hunted, especially in late spring. There is evidence of co-evolution between the Iberian lynx and the European rabbit, the lynx adapting both its weight and its energy needs (the consumption of one adult rabbit per day, about 600 kcal) to coincide

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http://dx.doi.org/10.1016/j.jas.2013.03.006

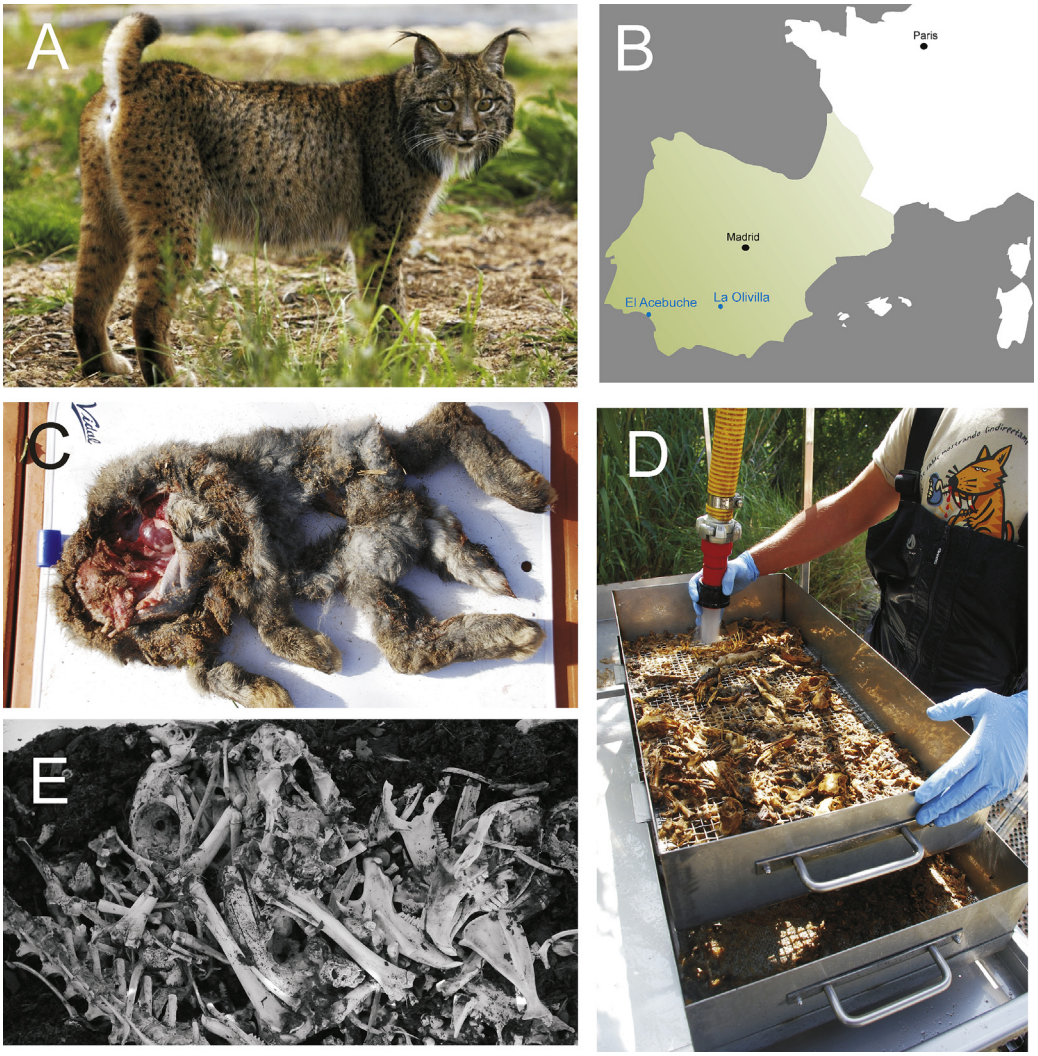

Fig. 1. **A**: Adult specimen of Iberian lynx, Iberian Lynx Ex-situ Conservation Program. **B**: Probable maximum expansion area of the Iberian lynx and location of captive breeding centers from which the samples were recovered. **C**: Example of recovered remains at both centers prior to treatment. **D** and **E**: Treatments of the samples, skeletonization and washing.

with the supply of these lagomorph populations in the Mediterranean area (Aldama et al., 1991). However, their diet may be supplemented with small mammals, reptiles, birds and small ungulates of usually less than 50 kg (Delibes, 1980; Blanco, 1998; Gil-Sánchez et al., 2006). This high degree of prey specialization has been suggested as the main cause of the Iberian lynx's decline as a species, in keeping with the decline of its primary prey (Delibes et al., 2000; Rodríguez and Delibes, 2002).

With regard to their feeding behaviour, the Iberian lynx is mostly a solitary predator although it has been found to occasionally hunt in pairs or small family groups (females and cubs) (Aldama and Delibes, 1991a, 1991b). When the Iberian lynx captures its prey, it normally transports them to a safe place to eat. The transport range in relation to the kill spot varies from a few metres to about one kilometre (Valverde, 1957; Delibes, 1980).

During the breeding season, the females occupy different dens to which they systematically move captured prey to feed their young. Because of the dependence of the young, the female's nutritional requirements increase during this period and force it to capture an average of two to three rabbits per day (Aldama et al., 1991; Aldama, 1993). Females preferentially choose holes in trees, rocks, caves and rock crevices for their breeding dens (Fernández and Palomares, 2000; Fernández et al., 2002). The transport of prey to the den of their young, as well as frequenting caves and shelters, is a common behaviour of the Iberian lynx and other terrestrial predators. These activities can generate significant accumulations of bones and teeth from prey non-ingested leftovers and scats.

In the Mediterranean ecosystem of the Iberian Peninsula, rabbits are a key source of prey and are a staple in the diet of many predators. Wolves (*Canis lupus signatus*), foxes (*Vulpes vulpes*), wild cats (*Felis silvestris*) and other small carnivores regularly include rabbits in their diets. They are also common prey for various raptors, especially the Eurasian Eagle-owl (*Bubo bubo*) and the Iberian Imperial Eagle (*Aquila adalberti*) (Delibes and Hiraldo, 1981).

In most archaeological sites of the Iberian and Mediterranean region dating from the Palaeolithic to Mesolithic, leporids especially *O. cuniculus*, are the most abundant taxon (Aura-Tortosa et al., 2002; Hockett and Haws, 2002). Given the variety of potential agents that could have been responsible for their accumulation actualistic taphonomic studies have been developed with the aims of identifying the bone accumulator (type of predator) and characterising the type of assemblage (non-ingested, pellets or scats) (Guillem and Martínez Valle, 1991; Schmitt and Juell, 1994; Hockett,

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